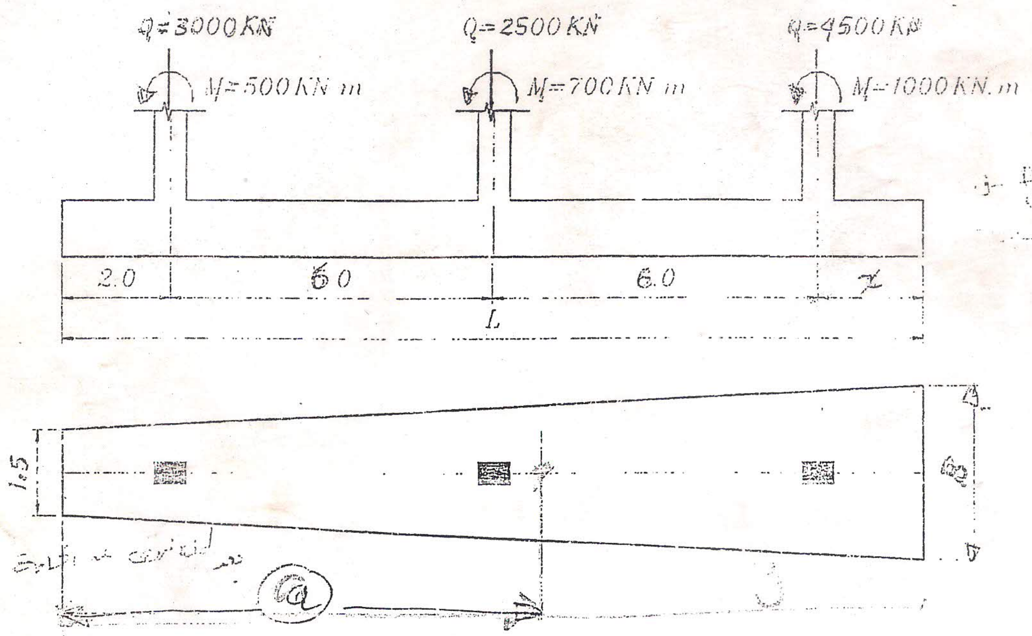
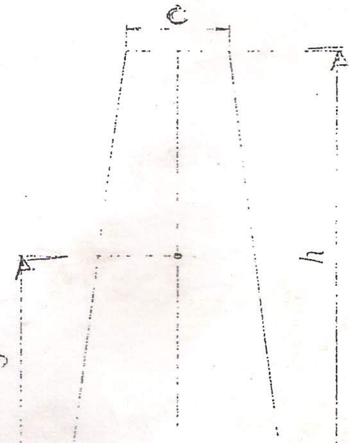
Problem # (9)

Consider the weight of footing and determine L and B of a trapezoidal footing for a uniform soil pressure of 300 kN/m^2, thickness of the footing is 1.0 m



Useful formula:

$$y = \frac{h}{3}\left(\frac{2c+b}{c+b}\right)$$



Solution:

$$\text{Weight of footing} = \left(\frac{1.5+B}{2}\right)\times L\times 24 = 12L(1.5+B)$$

$$\sum Q = 0$$

$$3000 + 2500 + 4500 + 12L(1.5+B) = 300\left(\frac{1.5+B}{2}\times L\right)$$

$$10000 + 12L(1.5+B) = 150L(1.5+B)$$

$Let\ (1.5 + B) = Y$

$10000 + 12\,LY = 150\,LY$

$10000 = 138\,LY$

$LY = 72.5$ ....(1)

$\sum M = 0$ (Moment taken about the centroid of the base)

$3000\,(a-2) + 500 + 2500\,(a-8) + 700 - 4500\,(14-a) + 1000 = 0$

$100\,a = 888 \Rightarrow a = 8.88\,m$

But;

$$L - 8.88 = \frac{L}{3}\left(\frac{2\times 1.5 + B}{1.5 + B}\right) = \frac{L}{3}\left(\frac{1.5 + Y}{Y}\right)$$

$3Y(L - 8.88) = 1.5L + LY$

$3LY - 26.64Y = 1.5L + LY$

$1.5L = 2LY - 26.64Y$ ....(2)

Substitute by LY from equation (1) in equation (2)

$1.5L = 2\times 72.5 - 26.64Y$

$$1.5L = 145 - 26.64\left(\frac{72.5}{L}\right)$$

$1.5L^2 - 145L + 1931.4 = 0$

$$L = \frac{145 \pm \sqrt{145^2 - 4\times 1.5\times 1931.4}}{2\times 1.5} = 15.95m$$

$$\therefore Y = \frac{72.5}{15.95} = 4.54 \Rightarrow B = 3.04m$$

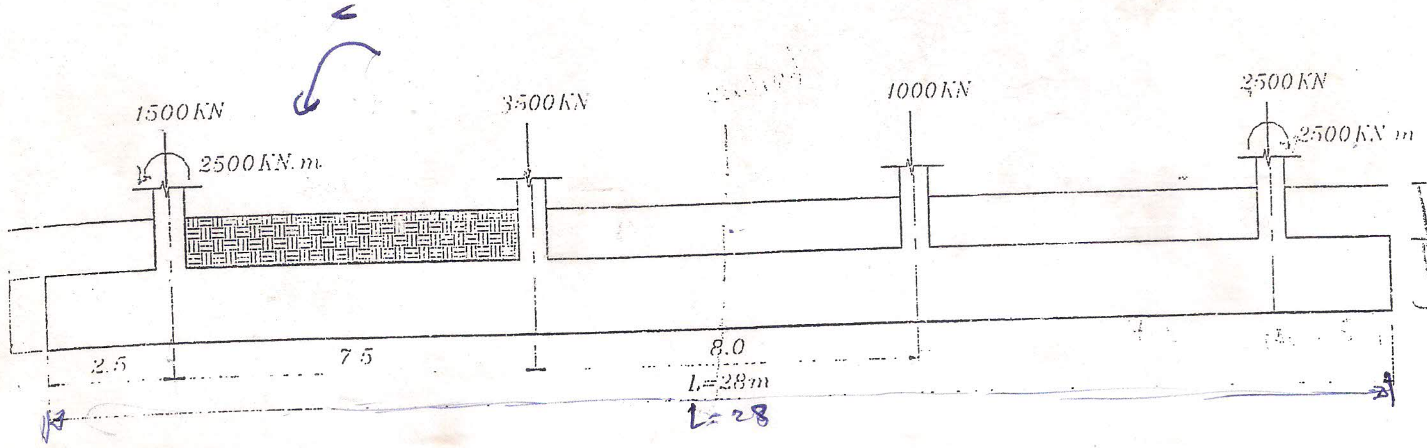
Problem # (12)

A combined footing consists of four columns as shown in figure, determine:

1- Width of the combined footing

Allowable gross soil pressure = 255 kN/m^2.

$\gamma_c = 24\,kN/m^3$ and $\gamma_{soil} = 20\,kN/m^3$



Solution:

Assume that the width of the footing is B

Weight of footing & soil = $28 \times B(1.5 \times 24 + 1 \times 20) = 1568\,B$

$\sum Q = 1500 + 3500 + 4000 + 2500 + 1568\,B = (11500 + 1568\,B)kN$

$\sum M$ (Moment taken about the centroid of the base)

$\sum M = -1500 \times 11.5 - 2500 - 3500 \times 4 + 2500 + 2500 \times 11.5 = 13500\;kN.m$

Eccentricity:

$$e = \frac{\sum M}{\sum Q} = \frac{13500}{11500 + 1568\,B}$$

$$q = \frac{Q}{BL}\left(1 \pm \frac{6e}{L}\right)$$

$$q_{max} = \frac{Q}{BL}\left(1 + \frac{6e}{L}\right) \Rightarrow 255 = \frac{11500 + 1568B}{28B}\left(1 + \frac{6 \times 13500}{28(11500 + 1568B)}\right)$$

$$255 = \frac{11500 + 1568\,B}{28\,B}\left(1 + \frac{81000}{322000 + 43904\,B}\right)$$

$$7140\,B = (11500 + 1568\,B)\left(\frac{403000 + 43904\,B}{322000 + 43904\,B}\right)$$

$$244633088\;B^2 + 1162280000\;B - 4634500000 = 0$$

$$B^2 + 4.751B - 18.945 = 0$$

$$\therefore B = \frac{-4.751 \pm \sqrt{4.751^2 - 4 \times -18.945}}{2} = \begin{matrix} 2.58m \\ 7.334m \end{matrix}$$

Take B = 2.6 m and check $q_{max} < (q_{all} = 255\ kN/m^2)$

$$q_{max} = \frac{11500 + 1568 \times 2.6}{28 \times 2.6}\left(1 + \frac{6 \times 13500}{28(11500 + 1568 \times 2.6)}\right) = 253.7 < 255 kN/m^2$$

$$q_{min} = \frac{11500 + 1568 \times 2.6}{28 \times 2.6}\left(1 - \frac{6 \times 13500}{28(11500 + 1568 \times 2.6)}\right) = 174 kN/m^2 > 0$$

Base pressure due to weight of soil & footing = 1.5x24 + 1x20 = 56 kN/m²

